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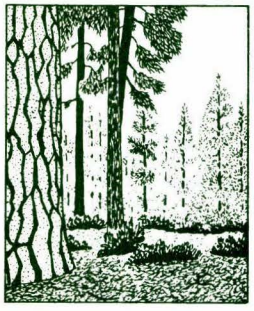

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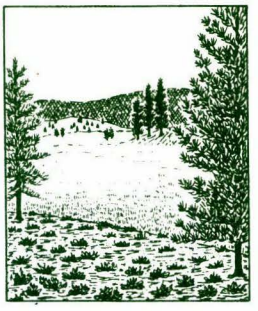

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RECENT TRIALS WITH 2,4-D AND 2,4,5-T TO KILL BRUSH IN THE SIERRA NEVADA IN CALIFORNIA

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Brush competition is one of the more serious obstacles to survival of both planted and naturally established trees in California. Brush has taken over many cutover and burned areas. In the western Sierra Nevada alone, 1.7 million acres of commercial forest land are classified as poorly stocked or non-stocked. 1/ All of this area is capable of producing forest trees, but brush dominates most of the ground and greatly hinders efforts by man and nature to reestablish conifers in adequate numbers. If these acres are to produce timber within a reasonable period, the brush must be either eradicated or killed in place. Chemical sprays offer one possibility for killing brush. This report describes the results of several experiments with two selective herbicides tested against five different brush species on the Stanislaus Experimental Forest.

Experimental Trials

Five experiments were designed to determine the effect of herbicides applied as foliage sprays at different times during the summer and fall on brush sprouts and old plants. The species studied were: Mountain whitethorn (Ceanothus cordulatus Kell.), Sierra evergreen-chinkapin (Castanopsis sempervirens Dudl.), bearmat (Chamaebatia foliolosa Benth.), littleleaf ceanothus (Ceanothus parvifolius Trel.), and greenleaf manzanita (Arctostaphylos patula Greene). The herbicides used were low volatile esters of 2,4-D (2-4-Dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid). Also tested were two substances, Tween 20 (polyoxyethylene sorbitan monolaurate) and Carbowax 1500 (an emulsified wax), as possible adjuvants to increase the

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1/ Forest Survey Staff. Forest Statistics for California. Calif. Forest and Range Expt. Sta. Forest Survey Release 25. 66 pp., illus. 1954.

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effectiveness of the herbicides. The five experiments were as follows:

Season and concentration for bearmat.--The first attempt to kill bearmat was started May 30, 1945. Mature plants on a series of milacre plots were sprayed with 2,4-D in a 1 percent solution of sodium carbonate at concentrations of 400, 800, 1,600, 2,400, and 4,000 p.p.m. 2/ Other dates of spraying were July 12, August 11, and October 12, 1945. Each treatment was replicated three times. One set of plots of each spray date was resprayed in October 1946 with 2,4-D at a concentration of 2,000 parts per million. One gallon of spray solution was applied per milacre with a backpack pump to which a disc spray nozzle had been added.

Bearmat sprout test.--On September 1, 1949, bearmat sprouts on 3.7 acres were sprayed with 2,4-D at a concentration of 2,000 p.p.m. The area had been logged and then cleared with a bulldozer in May 1949. The chemical solution was applied as a fine spray at 100 pounds per square inch nozzle pressure with a power sprayer. All plants were completely drenched with the herbicide, which was applied at the rate of approximately 200 gallons per acre.

Season of spraying and type of herbicide.--During the summer and fall of 1950, five clumps of young sprouts and five of old plants of mountain whitethorn and Sierra evergreen-chinkapin and 10 large old bushes of littleleaf ceanothus and greenleaf manzanita were sprayed with 2,4-D. A similar set of plants was treated with 2,4,5-T. Spraying was done on five dates at about monthly intervals. The herbicides were applied with a 5-gallon backpack pump equipped with a disc spray nozzle. All plants received sufficient solution at a concentration of 3,000 p.p.m. to wet the entire upper surface of the leaves.

Time of day.--On August 8, 1950, Sierra evergreen-chinkapin sprouts were sprayed with 2,4-D and 2,4,5-T at five different times during the day. Ten different clumps were sprayed with each herbicide at each spray time. The chemicals were applied at the same concentration and by the same method as in the preceding experiment.

Effect of adjuvants.--The last experiment was to determine if the effectiveness of the two herbicides could be enhanced by adding a small quantity of Tween 20 or Carbowax 1500. On October 3, 1950, mountain whitethorn sprouts were sprayed with 2,4-D and 2,4,5-T, with and without Tween 20 or Carbowax 1500. The concentration of the herbicides was 3,000 p.p.m. The adjuvants were added at the rate of 0.5 percent by volume of solution. Each spray treatment was applied on 5 bushes and each set of 6 treatments was replicated 5 times. A backpack pump was used as in the two preceding experiments.

2/ The abbreviation "p.p.m." as used in these trials refers to parts of pure acid equivalent per million parts of water.

Results

In the first test all 5 concentrations of 2,4-D--400, 800, 1,600, 2,400, and 4,000 p.p.m.--killed the bearmat foliage; however, they were not equally effective in preventing respouting from the stems and roots. The foliage of all plants sprayed in May and July were dead by the end of the first year. The foliage of plants sprayed in August and October did not die until the next summer. All the plants sprayed in May and July and all of those treated in August except at the 4,000 p.p.m. concentration resprouted the first year after treatment. Very few plants treated at concentrations of 2,400 and 4,000 p.p.m. in October resprouted. The set of plots resprayed in October of 1946 at a concentration of 2,000 p.p.m. and those treated with 2,400 and 4,000 in October 1945 were still relatively free of sprouts in 1955--9 and 10 years after treatment.

In the trial with bearmat sprouts, 2,4-D at a concentration of 2,000 p.p.m. killed all of the tops of the plants. Moreover, about 90 percent of the area was still free from bearmat in 1955, after 6 years. The area still containing bearmat is the rocky steep portion of the plot that had the densest brush cover at the time of treatment.

The third trial, with sprouts and old plants of four brush species sprayed at different times during the summer and fall, showed various responses to the herbicides. All littleleaf ceanothus bushes sprayed with 2,4,5-T and those sprayed with 2,4-D on August 4 and 24 were killed completely (table 1). All mountain whitethorn sprouts sprayed on June 30 and all greenleaf manzanita plants sprayed on September 28 with 2,4-D were killed; however, few old plants of mountain whitethorn and Sierra evergreen-chinkapin were killed. Spraying at any date reduced crown area of all species enough to suggest that competition was still reduced appreciably after 5 years.

The fourth test, to determine effect of spraying Sierra evergreen-chinkapin sprouts at different times during the day, showed that 2,4-D and 2,4,5-T were generally more effective when applied from 7:00 a.m. to 11:00 a.m. and least from 12:00 to 4:00 p.m. (table 2). Spraying after 5:00 p.m. with 2,4-D was as effective as the early morning application, but 2,4,5-T was less effective during the late afternoon than during the morning hours.

In the last test, neither Tween 20 nor Carbowax 1500 enhanced the effect of the herbicides significantly (table 3). The maximum kill of mountain whitethorn sprouts was produced by the solutions containing 2,4,5-T. These were three to four times as effective as the solutions with 2,4-D.

Table 1.--Percent foliage kill, crown reduction, and total kill by 2,4-D and 2,4,5-T sprayed on several brush species at 5 dates in 1950

Species and age of plants	Date sprayed	Maximum foliage killed		Crown area reduction, 1955		Entire plant killed, 1955	
		2,4-D	2,4,5-T	2,4-D	2,4,5-T	2,4-D	2,4,5-T
		Percent					
Mountain whitethorn:							
Young sprouts	6-30	100	92	100	80	100	80
	7-27	96	98	40	60	40	60
	8-23	96	96	50	80	40	80
	9-27	90	100	20	60	20	60
	11-10	84	100	0	80	0	80
Old plants	6-30	94	98	20	30	20	0
	7-27	82	100	20	36	0	20
	8-23	100	100	40	54	0	20
	9-27	90	100	16	18	0	0
	11-10	44	100	20	58	0	20
Sierra evergreen-chinkapin:							
Young sprouts	6-30	100	100	0	0	0	0
	7-26	56	90	8	42	0	20
	8-23	60	98	32	64	20	60
	9-27	28	100	0	90	0	60
	11-10	56	100	2	90	0	0
Old plants	6-30	46	98	10	38	0	0
	7-26	96	100	18	48	0	0
	8-23	56	100	16	68	0	0
	9-27	58	100	18	90	0	20
	11-10	20	94	0	22	0	0
Greenleaf manzanita:							
Old plants	7-3	90	100	76	95	60	90
	8-7	85	97	71	87	50	50
	8-24	95	96	94	90	70	50
	9-28	100	100	100	85	100	40
	11-10	97	100	95	91	90	60
Littleleaf ceanothus:							
Old plants	7-3	84	100	84	100	60	100
	8-7	100	100	100	100	100	100
	8-24	100	100	100	100	100	100
	9-28	43	100	43	100	30	100
	11-10	48	100	48	100	30	100

Table 2.--Maximum foliage kill, crown reduction, and total kill of Sierra evergreen-chinkapin sprayed in 1950 with 2,4-D and 2,4,5-T at 5 different times during the day

Time sprayed	Maximum foliage killed		Crown area reduction, 1955		Entire plant killed, 1955	
	2,4-D	2,4,5-T	2,4-D	2,4,5-T	2,4-D	2,4,5-T
	Percent					
7:00 to 8:30 a.m.	97	99	40	76	20	30
9:30 to 11:00 a.m.	88	99	31	64	10	40
12:00 to 1:30 p.m.	58	98	19	38	10	10
2:30 to 4:00 p.m.	58	94	5	41	0	0
5:00 to 6:30 p.m.	92	99	41	51	10	20

Table 3.--Maximum foliage kill, crown reduction, and total kill of mountain whitethorn sprouts sprayed with two adjuvants and herbicides in 1950

Treatment	Maximum foliage killed	Crown area reduction, 1955	Entire plant killed, 1955
	Percent		
Control:			
2,4-D	99	25	20
2,4,5-T	100	80	80
Tween 20:			
2,4-D	98	28	20
2,4,5-T	100	74	68
Carbowax 1500:			
2,4-D	91	28	24
2,4,5-T	100	79	76

Discussion

The effect of hormone sprays--2,4-D and 2,4,5-T--was found to vary with species, age of plant, and time of application. Complete kill was hard to achieve, but the total crown area of most species studied was reduced sufficiently to permit trees to compete favorably with the brush that survived spraying.

Littleleaf ceanothus was the least difficult to kill. All plants of this species sprayed with 2,4,5-T were dead within a year after treatment. The same results were obtained with 2,4-D when sprayed in August, but when sprayed earlier or later in the year 2,4-D killed only 30 to 60 percent of the plants. Since 2,4-D is cheaper than 2,4,5-T, it would be advisable to spray littleleaf ceanothus with 2,4-D in August. If treatment in August is impossible, 2,4,5-T should be used.

Bearmat was found to be most susceptible to 2,4-D after August; 2,4,5-T was not tested on bearmat. Concentrations of 2,000 to 4,000 p.p.m. of 2,4-D acid in water produced the best results.

Greenleaf manzanita was killed by both herbicides. All plants sprayed with 2,4-D at 3,000 p.p.m. on September 28 were killed. Of those sprayed in November, 90 percent were killed. If spraying is earlier in the year, 2,4,5-T should be used. A kill of 90 percent was recorded with 2,4,5-T when sprayed the first of July, but after that date 2,4-D was superior to 2,4,5-T.

Sprouts of mountain whitethorn were easier to kill than older plants. The best control was achieved by June 30 application of 2,4-D. After that date 2,4,5-T was more effective and therefore should be used for later spraying. It is possible that mountain whitethorn sprouts could be effectively sprayed with 2,4-D during the end of May and June. Very few of the old plants were killed by either herbicide. The best reduction of crown area was obtained with 2,4,5-T sprayed in November. Therefore, it is recommended that old mountain whitethorn be treated with 2,4,5-T during late fall. Further tests would be desirable to determine a more effective control of mature mountain whitethorn.

Sierra evergreen-chinkapin was the most difficult species to kill, although young sprouts were less resistant than old plants. Very few of the young sprouts and none of the older plants treated with 2,4-D were killed. Young sprouts should be treated with 2,4,5-T during September to November. Although none of the sprouts that were sprayed with 2,4,5-T on November 10 were killed, 90 percent of the crown area was eliminated. Best results with older plants were obtained with the 2,4,5-T on September 27, therefore it would be advisable to spray them with 2,4,5-T during September and possibly the early part of October.

The results of the time of day test on Sierra evergreen-chinkapin indicated that the plants should be treated during the early morning and late afternoon. The same finding may apply to the other four species, but it was not tested.

Neither of two adjuvants increased the killing power of herbicides at the concentration tested. Further tests should be conducted with wetting agents and chemicals that increase the absorption of lethal sprays by the plants. These substances should be tested on the more resistant species--especially old plants of mountain whitethorn and Sierra evergreen-chinkapin.